DECLARATION UNDER 37 CFR 1.132 OF JULIUS L. GOLDSTEIN

Julius L. Goldstein, being duly warned of the penalties for perjury as noted below, does hereby declare as follows:

1. That he is the inventor of the invention disclosed and claimed in the subject United States Patent Application Serial No. 09/935,510.

2. That he holds a Bachelor of Electrical Engineering (Cooper Union 1957), Masters of Electrical Engineering (Polytechnic Inst. of Brooklyn, 1960), and a Ph.D. degree in Electrical/Biomedical Engineering (Univ. of Rochester, 1965), and that he is presently president of Hearing Emulations LLC. His career accomplishments are recognized and summarized in Marquis' Who's Who in the World, in Science and Engineering, and in America. Attached hereto as Exhibit 1 is his curriculum vitae providing in greater detail his contributions to hearing science and engineering throughout his long career in academia and more recently as an inventor, including U.S. patent 5,402,493 (issued 3/28/95) and EPO grant EP1121834B1 (issued 4/02/03).

3. That he has read and studied the Final Office Action dated April 27, 2004 as well as the references cited therein, particularly U.S. Patent No. 4,887,299 (Cummins et al.) and U.S. Patent No. 5,848,171 (Stockham, Jr. et al.).

4. That upon such reading and studying of the Cummins and Stockham Jr. patents, he has concluded that, while the instant application, the cited Cummins patent, and the cited Stockham Jr. patent all deal with hearing aid technology, the instant application describes an invention that utilizes a wholly different technique to provide sound amplification, as will be more fully explained below.

5. That he profoundly disagrees with the statement on page 2 of the Final Office Action in the "Response to Arguments" section, wherein the Final Office Action states that the Cummins patent discloses the use of instantaneous compressive gain. On this point, the Final Office Action reads:

> Applicant alleges that the Cummins reference does not teach instantaneous gain compression referring to figure 4 in Cummins. Examiner disagrees with such an assertion because of the following reasons: 1) No gain change is truly instantaneous. Any signal processing system encounters an inherent processing delay as the processor must compute output gain values for the inputted values.

> That process cannot take place instantaneously. As Applicant has described instantaneous gain compression as an input/output relationship which does not rely on previous inputs, Examiner has interpreted that feature as one in which a signal processor uses a memory to look up output gain values, does not use any averaging, but nonetheless is not totally instantaneous. 2) Cummins uses a memory to calculate gain values. As taught in the abstract and column 2 lines 44-48, the digital signal processor has a programmable memory with the desired amplification characteristics of the user. 3) The delay mentioned by Cummins in figure 4 is to align the input samples with the calculated gain values. The delay is necessary because of the inherent processing delay associated with looking up the gain values, as mentioned in point 1 above. (See Final Office Action, page 2, lines 4-18).

6. As a first step in explaining how the Final Office Action has misinterpreted the Cummins patent relative to the claimed invention, one must first analyze what it means for the nonlinear amplifier in Fig. 1 of the present application to provide instantaneous gain compression. As stated in the instant application, "[w]hen compressive gain is said to be instantaneous, what is meant is that the input/output relationship is number in/number out; essentially, the compression is memoryless in that the output does not depend upon previous inputs." (See Application, page 9, lines 8-12; see also Figures 10, 12-16 (wherein the output at any instant is a function of the value of the input u at a single instant)). The basic equations on pages 26 and 28 for the transducers in the nonlinear amplifiers explicitly define the output at any instant as dependent upon the input u at that instant. Therefore, a person of ordinary skill in the art would interpret the claim term "instantaneous compressive gain" and its variants in the context of the application to mean (1) in a digital system, that the compressive gain of the nonlinear amplifier can vary sample by sample of the input, and (2) in an analog system, that the compressive gain of the amplifier can vary over a time span of the input that is smaller than the Nyquist interval of 0.5/BW, wherein BW is the bandwidth of the input. The use of the terms "memoryless" and "instantaneous" I/O functions are consistent with standard conventions in the hearing amplification device art; that is, the instantaneous nature of an instantaneous BPNL transducer refers to its output at any instant being a function of the input at that instant. In view of the foregoing, with respect to independent claim 2, one novel feature thereof is the use of instantaneous nonlinear transducers within, for example, the BPNL structure to implement a gain compression specification for hearing aids (see Figs. 7 and 10),

without necessitating adaptation requiring measurement of some time average of the input signal. A second novel feature of claim 2 is the use of adaptive compression thresholds to control waveform compression in the BPNL processing (see Fig. 1). Conventional hearing-aid amplifiers require adaptation to provide the specified gain compression. The conventional design philosophy is most explicitly illustrated in Figure 1 of Stockham Jr., as the implementation of gain compression with "multiplicative AGC", wherein the multiplier (being proportional to the desired gain) is a ***slowly adapted function of time*** that avoids signal distortion. Cummins also follows this conventional practice and further quantifies the desired time course for changes in their amplifier gain; the slow nature of which clearly reveals the novelty of the present design.

7. Column 3, lines 18-33 of the Cummins patent details the non-instantaneous nature of the Cummins patent's nonlinear amplifier. Cummins states that "[t]he ***time constants*** of the non-linear amplifier ***over which the gain remains substantially unchanged*** is an ***important*** characteristic which affects its performance." (See Cummins; col. 3, lines 18-20 (emphasis added)). Cummins further states "[t]he longer the time constant, the less compression of short term waveform changes is achieved. ***However, the shorter the time constant, the more distortion is introduced for a given expansion or compression ratio.*** In the system of the present invention, a time constant value of about ***1 to 2 milliseconds*** provides preferred performance." (See Cummins; col. 3, lines 21-27 (emphasis added)).

8. Therefore, it must be recognized that Cummins teaches that the amplifier gain will remain constant for a minimum duration of 1 to 2 milliseconds. ***In an 8 kHz digital amplifier, these teachings will result in the compressive gain remaining constant for the duration of at least 18 to 36 input samples,*** without regard to the values of those samples. This stands in stark contrast to the present invention wherein the compressive gain of the nonlinear amplifier in Fig.1 can vary sample by sample. Accordingly, it cannot be reasonably asserted that the Cummins patent teaches that the compressive gain is instantaneous because its digital nonlinear amplifier will not change its gain on a sample by sample basis.

9. Furthermore, the Cummins patent teaches away from the use of instantaneous gain compression because Cummins teaches that if the time constant is too short, distortion will adversely affect hearing aid performance. (See Cummins, col. 3, lines 22-24). Accordingly, a

person of ordinary skill in the art, upon reviewing the Cummins patent will not be motivated to use instantaneous gain compression because Cummins teaches that distortion from short time constants degrades performance. While Cummins recognizes that the amount of distortion perceived to be acceptable will vary for different hearing aid users (see Cummins, col. 3, lines 31-33), this recognition fails to provide any teaching to eliminate the 1-2 millisecond time constant altogether.

10. Furthermore, at col. 5, lines 32-35, Cummins teaches the use of an attack time of 300 ms and a release time of 2.5 s. These times constrain the time courses for implementing the required adaptive gain changes in a multiplicative AGC amplifier, wherein the target gains satisfy the gain compression specification (Gain vs. RMS input). The attack time is the interval during which the gain of the amplifier is reduced in response to a sharp increase in input sound level, while the release time is the interval over which the gain is increased for a sustained decrease in input sound level. During any small interval of 1-2 ms, the gain is substantially constant.

11. The teachings in Cummins correspond to conventional teachings in the art for "attack times" and "release times". Conventional art in the field teaches reasonable attack times for gain reduction and reasonable release times for gain increases. According to such convention, the choice of attack time is a trade-off that balances acceptable distortion versus the risk of overamplifying suddenly increasing input sound levels. Further according to convention, the choice of release time is a trade-off that balances the avoidance of unwanted gain increases during normal pauses in conversation versus temporary loss of desired gain following intense disturbances during a conversation. To implement these design trade-offs, conventional art teaches the use of amplifiers whose gain changes relatively slowly in time, a technique that can be referred to as "slowly varying multiplicative AGC".

12. In contrast, the present invention claims the use of instantaneous compressive gain. This implementation requires no adaptation to avoid overamplifying sudden increases in input sound levels. To control the distortion caused by instantaneous compressive gain, the present invention claims the use of an adaptive compression threshold, preferably in combination with the second bandpass filter of the generic BPNL signal processing structure (see Fig. 1). The target of the adaptation is a waveform quality appropriate for the signals being

processed (see Fig. 1). The temporal dynamics of adaptation in the present invention differ with respect to conventional art, even when processing similar signals. Two examples illustrate this claim. With relatively clean speech, waveform compression can be targeted to strengthen relatively weak speech components and enhance its intelligibility. Instantaneous compression in the present invention successfully provides this enhancement without gain adaptations for each speech syllable. When intense transient disturbances interfere with ongoing speech, the present invention provides gain compression for the disturbance without the conventional requirement for slowly acting gain adaptation and without consequent temporary loss of sensitivity following the disturbance.

13. The Stockham Jr. patent cited in the Final Office Action also fails to teach the use of instantaneous compressive gain, when considered alone or in combination with the Cummins patent. A reading of the Final Office Action indicates that Stockham Jr. is not asserted to disclose or teach the use of instantaneous compressive gain, but it will nevertheless be pointed out that Stockham Jr. is also deficient in this respect. Stockham Jr. discloses a generalization of Cummins, wherein conventional art for nonlinear amplification is applied to each of a set of frequency subbands spanning the desired audio range. Their "multiplicative AGC" nonlinear bandpass amplification (Fig. 1) comprises multiplication of the responses of linear bandpass filters by slowly varying multipliers that are proportional to the gain specified for the current average input signal level. Consistent with the slow time course of gain changes in the Cummins patent, Stockham Jr. requires no second filter following the "multiplicative AGC" to control nonlinear distortion. Thus, the generalization by Stockham Jr. of Cummins applies conventional art for adaptive gain compression, which is distinct from the present invention using instantaneous gain compression for nonlinear amplification of subbands of the full sound.

14. Therefore, upon analyzing the present application and its pending claims, the Final Office Action, and the cited Cummins and Stockham Jr. patents, one must be compelled to the conclusion that the Cummins and Stockham Jr. patents, when viewed individually or in combination, fail to disclose teach or suggest the use of instantaneous compressive gain, much less instantaneous compressive gain in combination with an adaptive compression threshold to control waveform quality. Instead, these cited references teach the use of slowly varying

multiplicative AGC wherein the gain is substantially unchanging for durations of 1 to 2 milliseconds, while targeted adaptive gain changes are executed during intervals 2-3 orders of magnitude larger. In contrast, with the claimed invention, the compressive gain at any instant in time will be responsive to the value of the compressor input at a single instant in time.

15. That all of the foregoing supports the conclusion that the methodologies of the Cummins patent and the combination of the Cummins patent with the Stockham patent are quite different than that of the claimed invention, and that is the conclusion of the declarant.

Further declarant sayeth not.

The undersigned being hereby warned that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 USC 1001, and that such willful false statements and the like may jeopardize the validity of the application, declares that he is properly authorized to execute this application on behalf of the applicant; and that all statements made of his knowledge are true and that all statements made on information and belief are believed to be true.

DATE: July 8, 2004

Julius L. Goldstein

Julius L. Goldstein

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel in the order listed on Form Page 2.
Photocopy this page or follow this format for each person.

NAME	POSITION TITLE
Julius L. Goldstein, Ph.D.	President, Hearing Emulations LLC

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Cooper Union, New York, NY	BEE	1957	Electrical Engineering
Polytechnic Institute, Brooklyn, NY	MEE	1960	Electrical Engineering
University of Rochester, Rochester, NY	Ph.D.	1965	Electrical Engineering/ Bioengineering

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications.

PROFESSIONAL EXPERIENCE

2001-	President, Hearing Emulations LLC, St. Louis
1999-2000	Senior Research Scientist, BECS Technology, Inc., St. Louis
1996-	Adjunct Prof. of Electr. Eng. & Bioeng., Washington Univ., St. Louis
1992-1996	Consultant (part time) to Audio and Acoustics Dept, Bell Labs (AT&T, Lucent)
1988-1996	Senior Research Scientist, Central Inst. for the Deaf, St. Louis
1986-1988	Visiting Prof., Johns Hopkins Univ., Bioeng. and EECS Depts.
1982-1990	Prof. of Electr. Eng., Tel Aviv Univ., Electr. Systems Dept., On leave 9/86-10/90
1973-1982	Associate Prof. in Communications and Bioengineering, Tel Aviv Univ.
1976-1978	Chairman of Electronics Department, Tel Aviv University, Israel
1973-1976	Chairman of Biomedical Engineering Program, Tel Aviv University, Israel
1971-1973	Associate Prof. in Electrical Engineering, MIT Dept. of Electrical Eng.
1968-1971	Assistant Prof. in Electrical Engineering, MIT Dept. of Electrical Eng.
1966-1968	Research Associate, Harvard University, Laboratory of Psychophysics
1965-1966	Postdoctoral Research, Inst. for Perception Research, Eindhoven
1960-1961	Instructor in Electrical Engineering, University of Rochester
1959-1960	Instructor in Electrical Engineering, Polytechnic Institute of Brooklyn
1957-1960	Staff Engineer, Polytechnic Research and Development Corp., Brooklyn

AWARDS (J.L. Goldstein, PI)

- NIH 5R44 DC04028, Hearing Aids Based on Models of Cochlear Compression, Phase I 1999-00, Phase II 2001-03, SBIR grants awarded at BECS Technology, Inc.
- NSF IBN-9728383, Statistical theory of peak detection for human hearing (8/15/98-2/14/00) at Wash. U.
- NIDCD R01-DC00737, Model of Nonlinear and Active Cochlear Signal Processing, 1990-95 at CID.
- NIH Senior Fellowship Grant NS08119, 1986-1988 at Johns Hopkins Univ..
- Tadiran Electronic Communications Co., Israel, Research Equipment Grant 1985 at TAU.
- Israel Ministry of Industry, Commerce, and Tourism, Research Grant 1980 at TAU.
- Binational Science Foundation (U.S.-Israel) Grant 1286, 1977-1980 at TAU.
- NIH Grant R01-NS10737, Aural combination tones: Pure and applied, 1972-1975 at MIT.
- NSF Postdoctoral, 1965-1966, Inst. for Perception Research , Eindhoven.
- NSF Summer, 1961-1963, Univ. of Rochester.
- NIH Biomedical Engineering, 1961-1965, Univ. of Rochester.
- Schweinberg Scholarship, Cooper Union.
- Fellow Acoust. Soc. Am., Life Senior Member IEEE, Member Collegium ORLAS, Member ARO.
- Biographical listings in Marquis Who'sWho in the World, in America, and Science & Engineering.

EXHIBIT
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RELEVANT PUBLICATIONS

Auditory Compressive Nonlinearity (Supported by NIH and CID)

Goldstein, J.L. (1967). Auditory nonlinearity, J. Acoust. Soc. Am. 41, 676-689.

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Goldstein, J.L. (1991). Modeling the nonlinear cochlear mechanical basis of psychophysical tuning. J. Acoust. Soc. Am. 90, 2267-2268 (A).

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Goldstein, J.L. (1995). Relations among compression, suppression, and combination tones in mechanical responses of the basilar membrane: data and MBPNL model, Hear. Res. 89, 52-68.

Goldstein, J.L. (1995). Model of nonlinear and active cochlear signal processing. Final Report, National Institute of Deafness and Communications Disorders Grant 5R01DC00737, 3/90-2/95.

Lin, T. and Goldstein, J.L. (1995). Quantifying two-factor phase relations in nonlinear responses from low characteristic-frequency auditory-nerve fibers, Hear. Res. 90, 126-138.

Lin, T and Goldstein, J.L. (1997). Implementation of the MBPNL nonlinear cochlear I/O model in the C programming language, and applications for modeling impaired auditory function. In W. Jesteadt (Ed.), Modeling Sensorineural Hearing Loss, Lawrence Erlbaum Assoc., Mahwah, NJ, pp. 67-79.

Psychophysical Detection Mechanisms (Supported by NSF and Bell Laboratories consulting)

Goldstein, J.L. (1967). Auditory spectral filtering and monaural phase perception, J. Acoust. Soc. Am. 41, 450-479.

Goldstein, J.L. (1973). An optimum processor theory for the central formation of pitch of complex tones, J. Acoust. Soc. Am. 54, 1496-1516.

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Goldstein, J.L. (1995). Peak detection in auditory sound discrimination predicts masking asymmetry. Technical Memorandum AT&T Bell Labs, 24 pp., 8/22/95. [Overview reported in Goldstein (2001) below.]

Goldstein, J.L. (1995). Comparison of energy and peak detection for auditory masking of tones by narrowband noise, J. Acoust. Soc. Am. 98, 2907 (A).

Goldstein, J.L. (1996). Stimulus fluctuations in auditory intensity discrimination, J. Acoust. Soc. Am. 99, 2541 (A).

Goldstein, J.L. (1999). Statistical theory of peak detection for human hearing. J. Acoust. Soc. Am. 106, 2147 (A).

Goldstein, J.L. (2000). Pitch Perception. In A.E. Kazdin (Ed.), Encyclopedia of Psychology. Am. Psych. Assoc. & Oxford Univ Press.

Goldstein, J.L. and Hall, J.L. (1995). Peak detection for auditory sound discrimination, J. Acoust. Soc. Am. 97, 3330 (A). [Included in NIDCD Final Report, 1995.]

Goldstein, J.L. and Hall, J.L. (1999). Temporal factors in auditory peak detection of modulation of tones. J. Acoust. Soc. Am. 106, 2147 (A).

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Hearing Aids Based on Models of Cochlear Compression (Supported by NIDCD)

Goldstein, J.L. (1997). Cochlear signal processing for compression and gain control extends dynamic range and preserves temporal modulation. Poster II-P-26, NIDCD/VA Hearing Aid R&D Conference (9/22-24/97).

Goldstein, J.L., Valente, M., Chamberlain, R., Gilchrist, P., and Ivanovich, D. (2000). Pilot experiments with a simulated hearing aid based on models of cochlear compression. Poster PA19, Intl. Hearing Aid Research Conference-IHCON2000 (8/23-27/00).

Goldstein, J.L., Valente, M., and Chamberlain, R. (2001). Acoustical and psychoacoustical benefits of adaptive compression thresholds in hearing aid amplifiers that mimic cochlear function. Acoust. Soc. Am. Meeting in Chicago, 6/5/01. Invited paper for session 2aSC honoring Harry Levitt., J. Acoust. Soc. Am. 109, 2355.

Goldstein, J.L. (2002). Hearing aids based on models of cochlear compression using adaptive compression thresholds. U.S. Pat. Appl. Pub. No. US 2002/0057808 A1 (Appl. 09/935,510 filed 8/23/01).

Goldstein, J.L., Oz, M., Gilchrist, P.H. and Valente, M. (2002). Alternative compressive hearing aid algorithms derived from loudness psychophysics and cochlear models. Poster PB19, Intl Hearing Aid Research Conference-IHCON2002 (8/21-25/02).

Goldstein, J.L., Oz, M., Gilchrist, P.H., and Valente, M. (2003). Signal processing strategies and clinical outcomes for gain and waveform compression in hearing aids (Invited Paper). Proc. of 37th Asilomar Conf. on Signals, Systems, and Computers, 391-398. IEEE ISBN 0-7803-8104-1.

Chamberlain, R.D., Goldstein, J.L., and Ivanovich, D. (2003). Implementation of hearing aid signal processing algorithms on the TI DHP-100 Platform (Invited Paper). Proc. of 37th Asilomar Conference on Signals, Systems, and Computers, 404-409, IEEE ISBN 0-7803-8104-1.

Goldstein, J.L., Oz, M., Gilchrist, P.H., and Valente, M. (2003). Intelligibility benefit of waveform compression in an essentially

nonlinear hearing aid. Poster 3 at NCRAR Conference, Oct. 9-10, 2003.

Goldstein, J.L. (2004). Hearing Aids Based on Models of Cochlear Compression. Final Report NIDCD SBIR Grant 5R44DC4028.

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Goldstein, J.L., Oz, M., Gilchrist, P.H., and Valente, M. (2004). Hearing aids based on models of cochlear compression. Poster B21 at Scientific session for completed Phase 2 SBIR/STTR projects. 6th Ann. NIH SBIR/STTR Conf. June 23-24.

PATENTS

Electronic simulator of non-linear and active cochlear spectrum analysis. U.S.A. Patent 5,402,493 issued March 8, 1995, JL Goldstein inventor.

Hearing aids based on models of cochlear compression. European Patent 1,121,834 B1 issued April 3, 2003, JL Goldstein and RD Chamberlain inventors.

Hearing aids based on models of cochlear compression. USPTO application 09/158,411 filed September 22, 998, JL Goldstein Inventor. (Approved 4/20/04 for issue).

Hearing aids based on models of cochlear compression using adaptive compression thresholds. USPTO CIP application 09/935,510 filed August 23, 2001, JL Goldstein, inventor.